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November 9, 1994

U.S. Nuclear Regulatory Commission
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Washington, D.C. 20555

SUBJECT: River Bend Station - Unit 1
Docket No. 50-458
License No. NPF-47
Licensee Event Report 50-458/94-027
File Nos. G9.5, G9.25.1.3

RBG- 41053
RBF1-94-0106

Gentlemen:

In accordance with 10CFR50.73, enclosed is the subject report.

Sincerely,

James J. Fisicaro

JJF/kvm
Enclosure

150061

JE22

cc: U.S. Nuclear Regulatory Commission
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NRC FORM 366 (5-92)	U.S. NUCLEAR REGULATORY COMMISSION	APPROVED BY OMB NO. 3150-0104 EXPIRES 5/31/95

LICENSEE EVENT REPORT (LER)

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
River Bend Station	05000-458	01 of 07

TITLE (4)
TGSCC of CRD Piping Due to Inadvertent Contamination with a Chloride Bearing Substance

EVENT DATE (5)			LER NUMBER (6)			REPORT DATE (7)			OTHER FACILITIES INVOLVED (8)	
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	MONTH	DAY	YEAR	FACILITY NAME	DOCKET NUMBER
									N/A	05000
10	10	94	94	027	00	11	09	94	N/A	05000

OPERATING MODE (9)	4	THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR § (Check one or more (11))			
POWER LEVEL (10)	0	20.402(b)	20.405(c)	50.73(a)(2)(iv)	73.71(b)
		20.405(a)(1)(i)	50.36(c)(1)	50.73(a)(2)(v)	73.71(c)
		20.405(a)(1)(ii)	50.36(c)(2)	50.73(a)(2)(vii)	OTHER
		20.405(a)(1)(iii)	50.73(a)(2)(i)	50.73(a)(2)(viii)(A)	(Specify in abstract below and in text, NRC Form 366A)
		20.405(a)(1)(iv)	X 50.73(a)(2)(ii)	50.73(a)(2)(viii)(B)	
		20.405(a)(1)(v)	50.73(a)(2)(iii)	50.73(a)(2)(x)	

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER (Include Area Code)
Timothy W. Gates, Supervisor - Nuclear Licensing	504-381-4866

COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS	CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS

SUPPLEMENTAL REPORT EXPECTED (14)		EXPECTED SUBMISSION DATE (15)	MONTH	DAY	YEAR
YES (If yes, complete EXPECTED SUBMISSION DATE)	X NO				

ABSTRACT (Limit to 1400 spaces, i.e., approximately 15 single-spaced typewritten lines) (16)

On October 10, 1994 at approximately 0100, with the plant in Operational Condition 4 (cold shutdown), a control rod drive (CRD) pipe was found to be cracked and leaking. This condition was identified by plant personnel exhibiting a noteworthy level of attention to detail during a scheduled walkdown/visual inspection of the drywell prior to plant startup. Investigations were performed which determined that a total of eight CRD pipes, and a section of the 'A' variable leg narrow range level pipe were affected and required repairs. Detailed analyses of this condition concluded that the failure mode was chloride induced Transgranular Stress Corrosion Cracking (TGSCC). The event which created the opportunity for the TGSCC is suspected to be a spill of high chloride bearing Therma-Cel 950 adhesive on the piping during the plant construction or early refueling outages.

Immediate corrective actions were taken to replace those sections of stainless steel pipe that exhibited crack indications. The balance of the plant equipment that could have been susceptible to this degradation has been addressed. To preclude recurrence, the chemicals used in the power block will be evaluated and additional control measures will be instituted, if appropriate. This condition did not pose a significant safety hazard. A review of LERs at RBS did not reveal any similar events.

TEXT (If more space is required, use additional copies of NRC Form 366A) (17)

REPORTED CONDITION

On October 10, 1994 at approximately 0100, with the plant in Operational Condition 4 (cold shutdown), the CRD (*AA*) piping (*PSP*) on control rod 44-33 insert line was found to be cracked and leaking. This condition was identified during a scheduled walkdown of the drywell prior to plant startup. A visual inspection revealed an unknown brown hardened substance on the affected piping around the crack. When conditions allowed, detailed investigations were performed which determined that a total of eight insert or withdrawal CRD pipes, and a section of the 'A' variable leg narrow range level pipe exhibited similar degradation. Since this condition could potentially create a serious degradation of a principle safety barrier, this condition is reported pursuant to 10 CFR 50.73(a)(2)(ii).

INVESTIGATION

As stated above, the adverse condition associated with the CRD piping on control rod 44-33 was identified by plant personnel during a scheduled plant walkdown. The individual who found the condition demonstrated a noteworthy level of attention to detail because the tell-tale leakage was very minimal. Subsequent to this initial finding, further inspections of the CRD insert and withdraw lines at azimuth 85 degrees and the surrounding areas were performed on October 12, 1994. A foreign material was identified on the surface of the piping, grating and several cable conduits in the area. The foreign substance appeared reddish-brown in color and was dried onto the surface. It appeared initially that a liquid had spilled from higher elevations in the drywell. It had the same consistency as dried paint and was difficult to remove from the surface that it contacted. The material path was traced up above the CRD piping by the splatter trail.

On October 14, 1994, a general inspection of uninsulated stainless steel piping in the Drywell was performed to determine if there was any other piping having the "brownish solid deposit" that seemed to be the common denominator of the corrosion/cracking phenomenon. Three teams of three persons each conducted the inspection. As a result of these and additional walkdowns in the containment, Radiation Monitoring System (*IL*), Containment Atmosphere Monitoring System (*IK*), and Standby Liquid Control System (*BR*) piping were examined by ultrasonic testing (UT) and determined to be free of cracks.

Samples of the foreign material deposited on piping were analyzed for chemical composition at commercial laboratories. These analyses commonly indicated high levels of chlorides and the presence of iron, copper, zinc and other minor constituents. The composition of these samples was compared with potential candidate sources.

Based on the available chemistry results and locations of the affected piping, the foreign material was determined to most likely be the Therma-Cel 950 adhesive. Other possible, but less probable, sources of foreign material were also analyzed and ruled out in the investigation.

Therma-Cel 950 was approved for use on chilled water and service water piping for anti-sweat insulation at River Bend Station during construction. The Chemical Permit for use of this adhesive was discontinued on 2/01/90. It was also determined that the production of Therma-Cel 950 was discontinued in 1988 and that it had a shelf life of one year.

A nondestructive investigation of the CRD lines was conducted using UT methods. The following pipes, with the characteristic brownish deposits, were found to have outside diameter flaws:

1RDS-125-3233 insert
1RDS-125-3233 withdraw
1RDS-125-3633 insert
1RDS-125-3633 withdraw
1RDS-125-4033 insert
1RDS-125-4433 insert
1RDS-125-4833 insert
1RDS-125-5233 insert
1RCS-750-33-2 variable leg "A"

Initial UT testing was directed to piping with the same heat number around the problem area. Subsequently, additional lines were examined to determine if other material heat numbers or deposits were a potential root cause. All of these additional lines were found to be free of defects.

Axial cracks which allowed weepage to occur existed on only one insert line of the CRDs. This was determined by non-destructive UT. These cracks were further evaluated to establish the cause of the cracking. The evaluation consisted of a detailed visual examination with the aid of a Stereo Microscope, Scanning Electron Microscopy (SEM), analysis of fracture surface corrosion products and deposits, Energy Dispersive Spectroscopy (EDS), Metallography, and Optical Emmersion Spectroscopy (OES) for base metal chemistry determination. The results obtained from these analytical evaluations form the basis for determination of the cause. The cause of the cracking was determined to be TGSCC initiating on the outside diameter of the pipe and penetrating through the wall. Testing of the brown colored deposit and the corrosion product on the fracture surface showed the presence of chlorides. Hence it is shown that the cracking mechanism was chloride-induced TGSCC.

The conditions required to promote Stress Corrosion Cracking (SCC) were also investigated for the purposes of bounding this condition. For SCC in chloride environments (>10ppm) to occur, the temperature has to be above a minimum threshold of 140°F. Therefore, below 140°F the likelihood of SCC occurring is very low. The other controlling factor is stress loading. The threshold stress for 304 stainless steel is conservatively estimated to be 10.0 ksi. The pertinent loading for axial flaws is from hoop stress. The stress values associated with various system's piping in conjunction with the expected temperature conditions were analyzed to evaluate susceptibility of various system's piping to SCC.

CONCLUSIONS

Stainless steel piping in the plant that could have had a potential for exposure to chloride contamination was inspected. Eleven pipes in containment, four pipes in the fuel building, and no pipes in the auxiliary building were identified as potentially having the same type of deposit which contributed to chloride contamination on the CRD lines. At these locations, no cracks were found on the lines that had the material per UT inspection. The probable reason for this finding is that the piping fell below the minimum threshold limits for temperature (140 degrees F) and sustained applied stress (10.0 ksi).

The list of susceptible pipe was developed using the line designation tables and the above criteria. The physical locations of these lines were listed and all lines inside the Drywell and Containment were eliminated based on previous walkdowns. The final list of lines meeting the criteria were eliminated by the completion of the auxiliary building and fuel building walkdowns and the elimination of non-safety related piping in the turbine building.

The contaminated piping found in the drywell experienced environmental conditions which were conducive to TGSCC. Other areas of the plant were reviewed to determine if conditions existed which could be conducive to SCC. Fracture Mechanics Analyses were also performed which showed that the affected piping contained sufficient margin to insure structural integrity of piping for part through wall and through wall cracks. Based upon this analysis, extensive visual inspection, and exclusion criteria stated above, we have concluded that a generic problem resulting in gross failure of stainless steel piping due to TGSCC does not exist at River Bend Station.

ROOT CAUSE

Event and causal factor analysis was utilized to determine root cause of this event. The failure mode was determined to be chloride induced Transgranular Stress Corrosion Cracking (TGSCC). The event which created the opportunity for the TGSCC is suspected to be a spill of high chloride bearing Therma-Cel 950 adhesive on the piping during the plant construction or early refueling outages.

Contributing causes were the lack of a sufficiently comprehensive chemical control program during the construction and early operational phase of the plant, an apparent lack of personnel accountability regarding the use of chemicals inside the containment, and the failure to recognize the adverse conditions that could result from the splattering of the Therma-Cel 950 during its application.

A review of LERs at RBS did not reveal any similar events. Note, however, that RICSIL-052 documents similar CRD insert and withdrawal line cracking caused by chloride induced TGSCC at Fukushima, Brunswick and Duane Arnold. Sources of chlorides were different in each case and ranged from sea water, cable insulation, and an unknown source. The known failure mechanisms described in this RICSIL were reviewed and determined not to be applicable to RBS. Generic actions to help identify the potential for SCC due to unknown chloride contamination sources were also evaluated. RBS's review following receipt of the RICSIL concluded that the existing plant programs (e.g., scheduled system walkdowns and surveillances, the IST/ISI program, reactor system hydro test, etc.) were adequate for identifying any degradation that could potentially occur. Note that this condition was identified during a normally scheduled pre-startup walkdown. The RICSIL evaluation was reviewed as a result of this event and found to be satisfactory given the indications available at the time.

CORRECTIVE ACTIONS

The following immediate corrective actions have been taken to correct and bound the identified condition.

- The eight CRD pipe sections and the one RCS pipe section which exhibited crack indications as a result of TGSCC have been replaced.
- Area inspections were conducted to identify plant equipment that could have been exposed to the adhesive.
- All CRD pipelines found bearing deposits of Therma-Cel 950 have been cleaned, inspected and evaluated.

To preclude recurrence, the following long-term corrective action is being pursued.

- Chemistry will re-evaluate all current chemical permits used in the power block to identify materials which contain chlorides. Additionally, these permits will be reviewed to ensure that appropriate restrictions exist to govern use of these materials. This action will be completed by January 18, 1995.

TEXT (If more space is required, use additional copies of NRC Form 366A) (17)

- Lessons-learned training will be conducted on the event discussed in this LER.

- EOI management has recognized the need to improve personnel accountability and to heighten the awareness of personnel to identify conditions which could have adverse consequences. Generic actions being implemented in these areas and are described in RBS's Long Term Performance Improvement Plan. Details of these programmatic improvements are provided in Section 9, "Problem Identification and Problem Solving;" Section 10, "Problem Identification and Root Cause Evaluation;" and Section 13, "Human Performance Effectiveness."

SAFETY ANALYSIS

As discussed above, several CRD pipes and a variable leg pipe were found with indications and cracks. The degradation mechanism was determined to be Transgranular Stress Corrosion Cracking (TGSCC) which was induced in the stainless steel piping by the presence of chlorides in the adhesive. This cracking was axial in alignment and was limited to an area directly under a foreign substance which was located on the outside diameter surface of the piping.

A detailed metallurgical examination of the worst-case pipe determined that only a limited number of the axial cracks noted on the outside diameter surface penetrated through the pipe wall. The axial cracks on the outside diameter were discontinuous with each individual crack being short and discrete (i.e. intact ligaments existed between the cracks). This evaluation concluded that the initiation and the propagation of the TGSCC cracks occurred as a single event. The driving mechanisms (i.e., free chlorides) of TGSCC is greatly reduced when the deposited material dries; therefore, the pitting and etching associated with TGSCC cease.

No gross failures of the CRD piping have occurred as a result of this mechanism at RBS. Given the calculated CRD pipe stresses, an analysis was performed to determine the critical crack length to assess the margin of safety based on the observed crack lengths. For the longest observed crack length on the worst-case CRD insert pipe, there was a 30% margin on pipe stress against gross pipe failure.

From a systems perspective, the function of the CRD system is to position the control rods for the purpose of controlling the criticality of the reactor. The system's most significant safety function is the ability to Scram the reactor when required. The greatest challenge this condition could impose on this system has been postulated to be a gross failure of a CRD insert line. However the system has been designed with the ability to perform its Scram function with the failure of an insert line. The control rods are Scrammed by opening the insert portion of the drive system to a volume of high pressure CRD water and opening the exhaust (withdrawal) side to atmospheric pressure. This differential pressure quickly drives the control rods into the reactor core. Each CRD mechanism is provided with a ball check valve on the insert side which is normally

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held closed against reactor pressure by the CRD drive water. Upon the loss of the system's ability to provide the required driving water to the insert side of the CRD mechanism, this ball check valve would change position and allow the high pressure reactor water to drive the control rod into the reactor. The water provided from the vessel will fully Scram each affected rod, as required.

It had been shown that no gross failures of the CRD system or the reactor pressure boundary occurred because of this condition. Furthermore, it has been shown that if a gross failure had occurred in the CRD system, the system would maintain its ability to safely shut down the reactor. Based on the above, it is concluded that this condition did not pose a significant safety hazard.

Note: Energy Industry Identification System Codes are indicated in the text as (*XX*)